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ABSTRACT

A study explored the effects of word processing on the revision strategies of 20 advanced college freshmen enrolled in a required writing course. Subjects were divided into two groups of 10, each of which alternately wrote a series of four essays on and off the computer. For each essay students submitted three drafts, which were analyzed for revisions. Each student produced two essays with word processing and two with pen and typewriter. In addition to undergoing text analysis, the essays were judged by trained raters using an analytical scale, so that the quality of the essays could be related to the number and kinds of revisions. Results of the analysis of 4,048 between-draft revisions of 80 essays indicated that writing on a computer did not lead to increased revision--at least not for these able students. The finding that there was no positive relationship between extensive revision and the quality ratings, however, suggests that manipulating text for the sake of revision has little value for students or their writing. Nor did the students make different kinds of revisions with a computer than they did with pen and typewriter. The essays produced with pen and typewriter, moreover, received ratings comparable in quality to those produced on the computer. (Author/HTH)

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THE EFFECTS OF WORD PROCESSING ON THE REVISION STRATEGIES OF COLLEGE STUDENTS

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ABSTRACT

This study explores the effects of word processing on the revision strategies of twenty advanced college freshmen enrolled in a required writing course. The purpose of the investigation was to discover whether students revise more extensively and more successfully with a computer than with conventional methods. The twenty students were randomly divided into two groups of ten that alternately wrote a series of four essays on and off the computer. For each essay, students submitted three drafts which were analyzed for revisions. Each student produced two essays with word processing and two with pen and typewriter. In addition to undergoing text analysis, the essays were judged by trained raters using an analytical scale. In this way the quality of the essays could be related to the number and kinds of revisions. Results of the analysis of 4,048 between-draft revisions of eighty essays indicate that writing on a computer does not lead to increased revision--at least not for these able students. The finding that there was no positive relationship between extensive revision and the quality ratings, however, suggests that manipulating text for the sake of revision has little value for students or their writing. Nor did the students make different kinds of revisions with a computer than with pen and typewriter. Those essays produced with pen and typewriter, moreover, received comparable quality ratings to those produced with a computer.

THE EFFECTS OF WORD PROCESSING ON THE REVISION STRATEGIES OF COLLEGE STUDENTS

Although many of its claims are unsubstantiated, word processing is often touted as a tool that enables instructors to teach writing through revision. There is no empirical evidence of which I am aware, however, that suggests students not only revise more frequently at a computer but also revise more effectively. The link between extensive revision and superior prose, moreover, has never been established. In other words, questions regarding whether word processing encourages revision and whether more revision is necessarily better revision are yet to be answered. If teachers are to use computers to help students learn to write, a description of the effects of word processing on students' writing behavior is desirable and necessary.

Related Studies

Research in Revision

In the past several years a number of studies focused on the revising habits of writers: both those who revise successfully, and those who revise unsuccessfully. One need only consider Sommers's (1978) case study of the revision processes of college freshmen and experienced adult writers, Bridwell's (1979) experimental study of the revising strategies of twelfth graders, or two articles by Faigley and Witte (1981, 1984) to realize the advances that have been made in developing theories and conceptual frameworks

of revision. Along with Murray (1978), these researchers highlighted the importance of this subprocess to the activity of writing.

Beach (1976, 1979) also observed revision processes and concluded that those students who revised well were able to evaluate their writing more effectively than those students who did not revise. Implicit in his research was the assumption that good writers revise more extensively than poor writers and that hence more revision creates better products. Dieterich (1976) questioned this premise, asserting that while he would agree that good writers revise, extensive revision is not a requirement of good writing. Britton (1980) agreed when he noted "that rhetoricians, in their current concern for successive drafts and revision processes in composing, may be underestimating the importance of 'shaping at the point of utterance'" (p. 61). Although Bridwell (1979) found that those twelfth graders who produced essays receiving the highest ratings revised more between drafts than the other students in her study, this finding does not necessarily support the notion that extensive revision is superior revision. Some students alter text over and over again yet fail to improve it. It would seem, then, that claims for the efficacy of extensive revision should be viewed cautiously and that this caution should be applied when promoting word processing.

Rather than restricting the kinds of changes writers make to syntactical units, Faigley and Witte (1981) added a

semantic component to revision research. According to their classification scheme, revisions that add new information to a text are considered "meaning changes" whereas changes in format and mechanics, or revisions to segments of meaning that can be inferred from the text, are "surface changes." In this way, the two researchers classified all text alterations as either "meaning changes" (microstructure or macrostructure) or "surface changes" (formal or meaning-preserving). In their study of the revision processes of expert adults, advanced students, and inexperienced students, Faigley and Witte (1981) found that expert adults made a greater percentage of "meaning changes" than advanced or inexperienced students. If word processing does indeed foster revision, it might be useful to consider the kinds of changes writers make in addition to the number of changes.

Research in Word Processing

Added to this research of revision in general are a few recent case studies that attempted to analyze the effects of word processing on the writing and revising habits of different categories of writers. Collier (1983) found that his four nursing students manipulated text more at a computer than with conventional methods but that the quality of their writing did not improve. In their research dealing with five undergraduate writers, Bridwell, Sirc, and Brooke (1985) noted that four students increased their revision with a computer. Their research did not involve assessing the quality of the writing samples. With eight

junior high school students as her sample, Daiute (1984a) described the kinds and number of revisions writers made with word processing. Her results suggested that some students increased their revision and made more types of changes with word processing but that the revised computer essays, in general, did not receive higher quality ratings than those produced with pen. Although she analyzed revisions using Faigley and Witte's (1981) classification scheme, she did not report the kinds of alterations students made in terms of "meaning" and "surface changes" on and off the computer. Another study that made use of Faigley and Witte's (1981) scheme was a case study involving six able undergraduates who produced four pieces of writing, the first two with conventional methods and the last two with word processing (Harris, 1985). Harris found that these students revised less frequently with word processing. Her study did not examine the quality of the student essays.

Previous research, then, has shown through case studies that while some writers make more and different changes with computers, others do not. Often, however, revision with a computer has not been studied in relation to the quality of writing produced.

Overview of Design

Purpose

Based upon the findings of the research reviewed here, there is a continuing need for explorations into the influence of word processing on writers and their writing.

The purpose of this experimental study was to discover whether students revised more extensively and more successfully with a computer than with pen and typewriter.

Design

To achieve this end, twenty students wrote nine essays during a semester, four of which were examined in two phases referred to as Episode A and Episode B. Episode A included the revisions between the first and second draft, and Episode B included the revisions between the second and final draft. For the two episodes, 4,048 between-draft revisions were counted and coded according to Faigley and Witte's (1981) classification scheme. In addition, trained raters, using Diederich's (1974) analytical scale, judged the quality of eighty first and eighty final drafts. This investigation also sought to classify the kinds of revisions students made with and without word processing to determine whether differences could be attributed to the writers themselves or to the tools with which they wrote. One of the principal strengths of this experimental research was that it examined the revising processes of the same twenty students through multiple pieces of writing on and off the computer.

Method

Research Questions

The following research questions guided this investigation:

1. Do students revise school writing more extensively with word processing than with pen and typewriter?

2. Are there differences in the kinds of revisions students make with word processing and with pen and typewriter?

3. Is there a relationship between the extent to which students revise and the quality of their school writing?

4. Do students revise school writing more effectively with word processing than with pen and typewriter?

Sample

The subjects included twenty college students enrolled in a required freshman rhetoric course taught in a classroom-laboratory setting in which there was a microcomputer for each student. The students had earned scores between twenty-five and thirty-one on the American College Test (ACT) composite and between twenty-three and twenty-seven on the English portion of the test. Of the twenty students, all were freshmen except one, a sophomore who had not taken rhetoric during his freshman year. His scores fell in the range of the others. Two of the twenty students had worked with word processing in high school but had used different computers and software. In general, the sample consisted of above average college students who were accustomed to succeeding in school. The students knew the study was concerned with writing and word processing but were unaware that their revision strategies lay at the heart of the research.

Design

The class was randomly divided into two groups of ten with each group producing two essay assignments with the aid of word processing and two essay assignments with the aid of pen and typewriter. By the time of the semester's fourth essay, the first to be used in this study, the class had been working with word processing for five and a half weeks. For Essay Four, Group I wrote and revised their assignment with pen and typewriter while Group II completed their essays with the help of a computer. For Essay Five, the two groups exchanged procedures. The same exchanges of procedures between the two groups were used for the sixth and seventh essay assignments as well. Table 1 outlines the design of the study.

Table 1

Design of the Study

Groups	Essay Assignments								
	1	2	3	4*	5*	6*	7*	8	9
Group I (n = 10)	T	C	C	T	C	T	C	C	C
Group II (n = 10)	T	C	C	C	T	C	T	C	C

T - essays written with the aid of pen and typewriter
C - essays written with the aid of a computer
* - essays included in the study

Writing Tasks

The writing tasks for each of the essays presented the students with a choice intended to result in a transactional piece of writing. As defined by Britton (1978),

transactional writing is writing "to get things done, whether it be in an operative mode of informing, instructing, or persuading people or in an intellectual mode of problem solving, speculating, theorizing" (p. 18). For the fourth essay assignment, the students chose a childhood book and compared their response to it as adults with their earlier, younger reactions. The fifth assignment offered four possibilities leading to papers of comparison or of cause and effect. The sixth assignment was designed to elicit essays of definition or classification, and the seventh and final assignment presented two choices for a persuasive essay. The research design--with students receiving identical instructional intervention--was intended to reduce the potentially biasing influences of topic and instructor. In other words, the only difference in the treatment of the two groups was whether the students used a computer or pen and typewriter as a tool in producing a particular essay.

Collection of Data

For each writing assignment, the students submitted three essay drafts. In-process revisions were not captured in this study although students were encouraged to revise as much as they wanted. The changes they made in moving from the first to the second draft (Episode A) and from the second to the final draft (Episode B) made up the data that were counted and categorized.

After students produced first drafts, they completed "self-assessment forms" designed to prompt revising and made changes on their drafts to indicate revisions. They also wrote out additional plans for revising their essays. For their final draft, they incorporated other desired changes. The three drafts for each essay were submitted over a two-week period. In this way, 240 drafts over the four essay assignments were collected from the twenty students.

The students did all their writing outside of class since half were always working with the computer and half were not. Although writing outside of class has fewer controls than a study that requires students to write in a prescribed setting over a particular period of time, the procedure has advantages: students have time to plan, reflect, and revise. It seems likely that when students are asked to write and revise in a classroom environment, one learns how students write and revise under test conditions rather than how they compose essays that are assigned without these constraints.

Teaching Revision

One of the challenges of the present research was to find teaching strategies that would help students improve their writing from one draft to another regardless of whether they worked with pen and typewriter or with word processing. A just criticism of early research with computers was that students were not taught how to revise--that writers cannot be expected automatically to revise

successfully when they are greeted with word processing (Pufahl, 1984). Throughout the semester, then, students were taught the mechanics of revising with word processing--moving, copying, deleting, and adding small and large chunks of text with the function keys--along with revision strategies that focused on the students' assessment of their own essays.

Beach (1976, 1979) conducted studies in which he tried to determine the benefits of students being taught skills that helped them evaluate their own writing. He came to the conclusion that "when writers begin to assess their drafts from their audience's perspective, they can judge whether or not their drafts are appropriate or effective" (1982, p. 74). Similarly, Daiute (1984b) set forth the idea that "as children mature, they learn to take perspectives other than their own, which is crucial in evaluating their own writing" (p. 206). And much of the thinking behind Flower's (1979) concept of "writer-based prose," in contrast to "reader-based prose," has to do with adapting one's writing to particular audiences. For these reasons Beach and Eaton's (1984) "self-assessment form" was used as a teaching tool to help students revise effectively.

By asking students to set goals and to focus on their desired readers' response, the "self-assessment form" was intended to encourage them to move from "internal" to "external" revision as described by Murray (1978). In other words, the form directed students to concentrate first on

discovering their meaning, (e.g. In general, what do you want to say in this paper?), and then to assess their effect on the audience, (e.g. What do you want your reader to do or think after reading it?). In addition to completing the "self-assessment forms" for the essays in the study, the students used them for the other essays in the course as well.

Students also engaged in pre-writing activities both on and off the computer. All assignments were made a week before the first draft was due, and students were asked to think about possible approaches to topics of their choice. Brainstorming on the computer was another activity in which students participated. These activities were designed to help students internalize their responses to the assignments and encourage them to make the topics their own.

Instrumentation

Revision Classification Taxonomy

To answer the first research question--Do students revise school writing more extensively with word processing than with pen and typewriter?--Faigley and Witte's (1981, 1984) taxonomy was used for counting and coding the changes that occurred in the drafts of student essays. This system also provided a perspective on the kinds of revisions students made so that the second research question could be answered: Are there differences in the kinds of revisions students make with word processing than with pen and typewriter? Revisions occurring in student essays were

categorized and coded before being added to an analysis sheet that organized the changes as either "surface changes," (i.e., formal or meaning-preserving), or "meaning changes," (i.e., microstructure or macrostructure).

To estimate the reliability of the revision codings, a post-doctoral student experienced in text analysis worked closely with me until we could agree perfectly on a sample of revisions in student essays not part of the study. As suggested by Faigley and Witte (1984), a list of rules I followed was also compiled, rules that my colleague subsequently followed as well. Ten percent of the essays in the study, including first drafts, second drafts, and final drafts, were selected randomly for re-analysis. Following procedures outlined by Bridwell (1979), every tenth revision coding was compared. For Faigley and Witte's categories of "surface changes" and "meaning changes," the percentage of agreement was 87%.

Analytical Scale for Rating Essays

To answer the third research question--Is there a relationship between the extent to which students revise and the quality of their school writing?--an instrument for gauging the quality of the essays was needed. This instrument also provided the data for the fourth research question: Do students revise school writing more effectively with word processing than with pen and typewriter?

Diederich's (1974) analytical scale with its criteria of ideas, organization, wording, flavor, usage, punctuation, and spelling was chosen over holistic instruments in which raters assign a general impression score. The category of handwriting was dismissed from the criteria since all pieces of writing were entered on a computer so that raters could not distinguish the typewriter essays from the computer essays.

Three raters were employed to score the essays, and each had extensive experience in evaluating writing. All members of a composition evaluation seminar, they had been trained in the International Evaluation Association's scoring system (Purves, 1984) and had rated writing samples for the Graduate Record Examination (GRE) and Test of English as a Foreign Language (TOEFL). Over a two-week period the raters were trained in applying the dimensions in Diederich's scale to a group of essays not in the study. After discussing various assigned ratings and reaching consensus, they rated the essays in the study. Ten percent of the essays were rated by all three so that reliability could be estimated using the method outlined by Lord and Novick (1968, p. 88). For total quality, the coefficient alpha was .78. Although the raters scored both first and final drafts, the essays were coded in such a way that they did not know which drafts they were rating. The assigned ratings were converted to percentages by dividing the raw

score by the total number number of points necessary for a perfect score (viz. 45).

Results

Frequency of Revision

The first task of this research was to discover whether students revised more with word processing than with pen and typewriter. By the end of the study, each group had written two essays with the aid of a computer and two essays with pen and typewriter, yielding 40 essays in each treatment.

Each group revised significantly more with pen and typewriter than with word processing. A t-statistic for related samples indicated that the difference between the mean frequency of revision with a computer and with pen and typewriter was significant at the .025 level. Table 2 displays the means, standard deviations, and t-statistics for the two sets of essays the students produced with either word processing or pen and typewriter.

Table 2

t-Test Showing Significant Differences between Frequency of Revision per 1000 Words in Two Sets of Essays Revised with Computer and Two Sets Revised with Pen and Typewriter

Method	Number of Essays	Means of Frequency of Revision	Standard Deviation	t-statistic
Computer	40	55.0/1000 words	24.1	
				2.44*
Pen and Typewriter	40	66.9/1000 words	21.2	

* $p < .025$

A pattern of revising more extensively with pen and typewriter than with word processing held true for each of the four essays. When revising with a computer, Group I made an average of 28.5 changes on Essay Five and 24.6 changes per 1000 words on Essay Seven whereas these same students averaged 35.8 and 32.0 changes per 1000 words with pen and typewriter on Essays Four and Six. Similarly, the students in Group II averaged 27.0 and 29.8 changes per 1000 words with a computer in Essays Four and Six and 31.6 and 34.5 changes per 1000 words with pen and typewriter in Essays Five and Seven. Table 3 presents a description of these revision patterns.

Table 3

Means and Standard Deviations of Total Combined Revision Changes per 1000 Words for Students with a Computer or with Pen and Typewriter

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Total Revisions: Episode A and Episode B

Method	Pen and Typewriter	Computer
Essay 4	Group I $\bar{x}$ = 35.8	Group II $\bar{x}$ = 27.0
	(n = 10) (sd = 16.1)	(n = 10) (sd = 14.5)
Essay 5	Group II $\bar{x}$ = 31.6	Group I $\bar{x}$ = 28.5
	(n = 10) (sd = 12.0)	(n = 10) (sd = 17.6)
Essay 6	Group I $\bar{x}$ = 32.0	Group II $\bar{x}$ = 29.8
	(n =10) (sd = 14.8)	(n = 10) (sd= 11.4)
Essay 7	Group II $\bar{x}$ = 34.5	Group I $\bar{x}$ = 24.6
	(n = 10) (sd = 12.9)	(n = 10) (sd= 11.6)

In this study, students made significantly more changes with pen and typewriter than with a computer. But the kinds of revisions students made with the two methods are also important. The second task was to determine if there were differences in the kinds of revisions students made on and off a computer.

Kinds of Revisions

Students made more changes in both the "surface" and "meaning" categories with pen and typewriter than with word processing. The pen and typewriter essays showed a greater frequency of "surface changes" per 1000 words in both revision episodes than the computer essays: 76.4 with the typewriter and 60.1 with the computer for Episode A and 47.1 with the typewriter and 37.3 with the computer for Episode B. For "meaning changes" students revised slightly more with a computer than with pen and typewriter during Episode A--64.6 changes with word processing compared to 62.1 changes per 1000 words with a computer. During Episode B, however, students made more "meaning changes" with pen and typewriter, incorporating 71.1 "meaning changes" per 1000 words compared to 65.1 per 1000 words with word processing. And, regardless of whether these academically able students revised with word processing or pen and typewriter, they achieved a higher frequency of "meaning changes" than "surface changes": 133.2 total "meaning changes" compared to 123.5 "surface changes" per 1000 words with pen and typewriter and 129.7 total "meaning changes" compared to

97.4 "surface changes" per 1000 words with word processing. That students added more "meaning changes" than "surface changes" on and off the computer might be interpreted to suggest that able students tend to make meaningful changes that result in good writing. The correlation between the frequency of "meaning changes" and the quality ratings, however, was non-significant. Another explanation for a greater percentage of "meaning changes," of course, is that better writers make fewer formal changes, changes that are necessary to correct misspellings, punctuation, and tense. In this study, there was a slight but non-significant negative correlation between the ratings for overall quality and the frequency of formal changes. Bridwell (1979) in her research of the revision of twelfth graders, however, found a small but significant negative correlation between the frequency of cosmetic revision changes and the quality ratings assigned to the essays for mechanics. It is highly possible that good writers don't necessarily make more meaningful changes but, in fact, fewer superficial changes.

That a greater number of "surface changes" were wrought with pen and typewriter than with word processing might well be attributed to this study's not capturing in-process revision. In other words, students may have changed formal mechanical errors more readily with word processing than with traditional methods and thus didn't need to edit these errors between drafts. Data describing these patterns of revision are presented in Table 4.

Table 4

Frequency per 1000 Words of Total Surface and Meaning Changes with a Computer and with Pen and Typewriter for Four Essays

Essays 4, 5, 6, 7:

Revisions	With Pen and Typewriter		With Computer	
	Surface	Meaning	Surface	Meaning
Episode A	76.4	62.1	60.1	64.6
Episode B	47.1	71.1	37.3	65.1
Totals:	123.5	133.2	97.4	129.7

Quality of Revision

The third task of this research was to determine if there is a relationship between the extent to which students revise and the quality of their school writing. For this sample, the frequency of revision was not significantly correlated with the quality ratings the students earned as a whole on each of the four assignments. Nor was there a significant correlation between the frequency of revision and the quality ratings across the four essay assignments. For Essays Four and Six there was a slight positive correlation between frequency of revision and quality whereas for Essays Five and Seven the correlation was negative. None of these correlations, however, was significant. The data are presented in Table 5.

Table 5

Correlations of the Frequency of Student Revision with Quality Ratings of Essays (n= 80)

Essay Assignments	Correlations
Essay Four (n = 20)	0.17 NS
Essay Five (n = 20)	-0.20 NS
Essay Six (n = 20)	0.35 NS
Essay Seven (n = 20)	-0.26 NS
Across All Four Essays (n = 80)	0.03 NS

Effective Revision

The fourth task of this research was to determine if students revise their essays more effectively with word processing than with pen and typewriter. That students revised more frequently with pen and typewriter doesn't necessarily mean that they revised more successfully since there appears to be no significant correlation between frequency of revision and quality. Overall, the quality ratings of the essays produced with pen and typewriter were remarkably similar to the ratings of essays produced with a computer. The typewriter essays earned a mean score of 84.6% and the computer essays 83.9%.

For most students, the writing tool did not seem to be the variable that affected the quality of their essays. Table 6 presents the means of the quality ratings expressed as percentages for the study's essays.

Table 6

Means of the Quality Ratings of Final Drafts for Two Groups at the Computer or with Pen and Typewriter (expressed as percentages)

Method	Pen and Typewriter Essays		Computer Essays	
Group I				
(n = 10)	4	6	5	7
$\bar{x}$	85.2	88.7	88.1	80.3
SD	(8.1)	(9.5)	(7.4)	(4.4)
Group II				
(n = 10)	5	7	4	6
$\bar{x}$	82.1	82.2	87.6	79.4
SD	(12.2)	(7.8)	(7.8)	(5.4)
Totals:				
$\bar{x}$		84.6		83.9
SD		(9.6)		(7.4)

The differences between these means were found to be non-significant using the Analysis of Variance Procedure. The Analysis of Variance did, however, yield two other important results. Regardless of whether they were revised with pen and typewriter or with a computer, or whether they were written by Group I or Group II, the four essay assignments received comparable ratings. In addition, the use of word processing was significantly more effective with the assignments for Essays Four and Five than for Essays Six and Seven. A summary of the data from the Analysis of Variance is displayed in Table 7.

Table 7

ANOVA Summary Table

Source of Variance	SS	df	ms	F	P
Between Blocks	1862.89	19			
Groups AB'	148.51	1	148.51	1.55	NS
Blocks within Groups	1714.38	18	95.24		
Within Blocks	3824.50	60			
A (modes)	9.11	1	9.11	16	NS
B (essays)	291.94	3	97.31	1.74	NS
AB'(within group)	504.18	2	252.09	4.50	<.01
AB x Block (within group)	3019.32	54	55.91		

Conclusions, Discussion, and Implications

The results of this study do not support the claim that a computer is a more effective revising tool than pen and typewriter, if one measures "effectiveness" by the frequency of revision and by the quality ratings assigned to the essays. At the same time, the results do not suggest that word processing is a less effective tool than conventional methods for students. Although students revised more with conventional methods, the quality ratings did not increase proportionately with the extent of revision. For the students in this study, more revision did not create superior essays. Nor, on the other hand, was infrequent revision more effective. Like Dieterich (1976) and Britton (1980), one might argue that for many it is not revision that determines quality. Rather it is whatever writers do

in the production of the first draft--that first utterance. In fact, Bridwell (1979) found in her investigation of the revision processes of twelfth graders that the rating on the first draft of a student's writing was a strong predictor of the final quality rating for that essay. The present study supports this generalization.

Discussion

Regardless of the merit of extensive revision, it seems unusual that students revised significantly more with pen and typewriter than with a computer. Although Daiute (1984a) found that there was not generally a difference in the quality scores of her students' essays produced with or without a computer, she did find that the students made more changes with word processing. Collier (1983) noted increased revision but, similarly, could not detect a difference in the quality of the writing. The experienced and professional writers in Lutz's (1983) study also revised and edited more at a computer than with traditional methods. Only in Harris's (1985) investigation did the students revise less with word processing.

Students may have revised more with pen and typewriter in this investigation because of the way the class was structured with its requirement of successive drafts. In other words, since students were asked to submit multiple drafts of their writing, regardless of whether they revised on or off a computer, they manipulated text as much with pen and typewriter as with word processing--in fact, more.

Daiute (1984a) suggested that children tend to make more extensive changes when they have to recopy, and the students in this study were, in essence, asked to recopy when they revised successive drafts with pen and typewriter.

A further consideration is that the students' work with word processing carried over to and affected their writing and revising with pen and typewriter. Daiute (1984a) found that children did more revising with pen after having used her word processing program for four weeks. Students in this study worked with a computer for five and a half weeks before submitting their fourth essay, the first to be used in this research. Their work with word processing, along with learning revising strategies based on Beach and Eaton's (1984) "self-assessment form," might have contributed to more extensive revision with pen and typewriter. Although the teaching of revision was intentionally built into the design to answer Pufahl's (1984) criticism that students won't necessarily revise successfully with word processing unless they are taught revision strategies, increased revision with the typewriter may have been encouraged.

The carry-over of strategies performed while using a computer might also be evident in the finding that word processing was more effective for writing and revising the fourth and fifth essays but pen and typewriter more effective for the sixth and seventh essays. One might argue that the influence of a computer for both the students who wrote Essay Four or Five with word processing, i.e., all the

students, affected the students' performance with pen and typewriter on Essays Six and Seven. In other words, the use of word processing for the nine and a half weeks preceding the sixth assignment--even when a computer wasn't used to produce some of the essays--influenced the students' revising with pen and typewriter. Or, stated more simply, word processing experience acted as an independent variable even when students were subsequently using pen and typewriter as tools.

After other explanations for the results are examined, however, the findings still offer little evidence that a computer or pen and typewriter affected the performance or the quality of writing differently. For these able students, the writing tool was apparently not the variable that influenced their revising strategies or the success of their essays. But for other students with different aptitudes, the medium might well make a difference.

Implications

This study sought to determine how a particular tool--word processing--might affect particular students and their products--a series of pieces of school writing. Perhaps we are asking too much when we expect a tool to transform the product, or perhaps we are asking too much too soon. In any event, the findings of this study suggest caution. Although word processing may lead students to approach the task of writing and revising with enthusiasm, a boon in itself for writing teachers, the computer is not a panacea for poor

writing or poor writing strategies. We must be wary, then, of extravagant claims. In discussing the future of computers in education, Papert (1983), for example, wrote:

> We take for granted that there should be a gap between the spoken and written language. Children learn to speak as babies without formal instruction. But the written language comes much later, if at all, and seems to require deliberate professional teaching. But why should this be so? Is writing really harder than speaking? I believe not and that the computer presence will close the gap. Perhaps it will even reverse the order in that mastery of writing may develop faster once it starts, than mastery of speech. (p. 100)

Such thinking is dangerous and uninformed: it ignores much of the research and theory that linguists, psychologists, and anthropologists have accumulated over the past century. Writing, unlike oral language, is not a natural process; instead, it is an activity that arises from a culture's need for a system of written symbols. Those of us who are teachers and researchers of language and writing must continue to explore the relationships among writers, writing, and computers so that we are not vulnerable to Papert's sort of thinking. By examining the effects of a computer on the activity of writing, we can, perhaps, move cautiously toward making the new technology work for us and our students.

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